International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 35 No. 1 Dec. 2021, pp. 140-152
© 2021 Innovative Space of Scientific Research Journals
http://www.ijias.issr-journals.org/

Diagnostic study of the conservation of yam tubers varieties in four communes of the Abidjan district (Côte d'Ivoire)

Camara Brahima, Ganemtore Souleymane, Traore Ibrahim, Kamara Adjata, and Kone Daouda

UFR Biosciences, UPR Physiologie et Pathologie Végétales, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire

ABSTRACT: Yam (*Dioscorea spp.*) occupies an important place in the diet of the populations of Côte d'Ivoire. However, during storage, significant losses due to fungi are observed. The objective of this work was to know if traders are aware of the difficulties they encounter during the storage of yam tubers. To do this, a survey was conducted in four communes in the District of Abidjan. It was found that more than 94% of traders encounter enormous difficulties, particularly rotting during the storage of yams before sale. This mainly soft rot (93.75%) causes the loss of 10 to 20% of stocks according to 56.25% of traders. Although 87.5% of the traders felt they knew the causes of the rots, fungi were not mentioned at all. This study is a preliminary study that could be a database for a possible study on the identification and control of these fungi responsible for post-harvest rots.

KEYWORDS: yam, fungi, rots, storage, survey.

1 INTRODUCTION

Yam (*Dioscorea spp.*) is a major food crop in many tropical countries in Asia, South America, Africa and especially West Africa [1]. Yam production in Côte d'Ivoire is divided between *Dioscorea alata* (60%), which accounts for almost all family consumption, and *Dioscorea cayenensis* (40%), which is intended for marketing [2]. The yam tuber is rich in starch, and thus provides a basic supply of energy. According to [3], yam (*Dioscorea spp.*) cultivation contributes to the food security of 300 million people in tropical countries.

In Côte d'Ivoire, yam occupies an important place in food crop agriculture because it alone accounts for 63.72% of the food crop area with a production of about 5.7 million tons [4]. It is also the leading non-cereal food crop with a yield of over 5.5 million tons in 2011 achieved on an area of over 830,000 ha [4]. Annual per capita consumption has increased from 105 to 120 kg over the last decade [5]. This nutritional function can only be fulfilled if its availability is guaranteed by an adapted conservation for a long period.

Unfortunately, many ecological and pest constraints prevent yams from making a significant contribution to the diet of people in many developing countries [6]. Losses during

storage are caused by external agents such as insects, rodents and moulds. In addition, the high water content of the tubers associated with the wounds that they undergo after harvest, expose them to microorganisms [7]. Work by [8] in Togo revealed that 80% of rotting occurs during traditional storage. According to [9], post-harvest rots of yam tubers are estimated at about 20-30% in Côte d'Ivoire. Yam rots due to microscopic fungi cause the greatest losses during storage [10].

Many traders sell yams in the markets of the communes of the District of Abidjan, where a significant amount of yams are rejected due to fungal rots [10].

The general objective of this work was to find out whether traders are aware of the difficulties they encounter when storing yams.

Specifically, it was about:

- Identify the difficulties encountered by traders when storing yams in stores;
- Identify types of yam tuber rots;
- Establish the relationship between yam varieties and types of rots;
- Estimate losses due to rot.

2 MATERIALS AND METHODS

2.1 STUDY SITE

The survey took place during the month of September 2019 in four communes located in the South of the District of Abidjan namely, Treichville, Marcory, Koumassi and Port-Bouët. This District has 13 communes and is characterized by a humid tropical climate with four seasons including two rainy and two dry. Temperatures vary between 25.3 and 32.5°C. An average of 1,784 mm of rain falls per year.

2.2 MATERIALS

The material used for the survey consisted of a questionnaire with 17 questions on yam storage and the traders themselves, a pen and a white coat

2.3 METHODS

2.3.1 CONDUCT OF THE SURVEY

The data was collected in the markets of four communes of the District of Abidjan, namely: Treichville, Marcory, Koumassi and Port-Bouët. The following criteria were used to define the sample of yam traders: be a yam trader, have a store dedicated to the marketing of yams in the commune selected for the study, and be available to answer questions. Based on these criteria, 16 traders from these four communes were selected and interviewed. Several data collection techniques were used, including direct observation, formal individual interviews via the trader survey questionnaires, and informal individual interviews or open discussions. The questions were asked directly to the traders and the answers were recorded as they were received. They were translated into Bambara for traders who could not speak French. The simplest questions were the first to be asked because some of them made traders reluctant. In order to allow traders to identify the parasitic constraints encountered during the storage of yams, we used a determination key, and the data collected during this survey were used to establish an Excel database. The data collected during the survey was used to create an Excel database. The conformity of the data sheets to the database was verified in order to reduce the risk of data entry errors. The analysis of the data was done with **Excel 2007** software.

3 RESULTS

3.1 PROFILE OF YAM TRADERS

The interviews revealed a high male dominance of 93.75% among yam traders, compared to only 6.25% for women (Table 1).

CHARACTERIZATION OF THE POST-HARVEST CONSERVATION SYSTEM FOR YAM INTENDED FOR MARKETING

The storage of yams in the stores of the four communes visited is almost traditional in small areas (stores). Several varieties of yams are stored in the same compound for marketing.

3.2 MARKETING RATE OF DIFFERENT YAM VARIETIES

During the surveys, it was found that the most marketed yam varieties were Kponan (100%), Assawa (100%), Bètè Bètè (90%), Klenglè (about 94%) and Florido (75%). The other seven varieties, namely Bana, Ya Assawa, Dindin, Abéka, Tréla, Lokpa and Korodougou, had the lowest marketing rates (Figure 1).

3.3 Difficulties Encountered By Traders In Storing Yams

This survey revealed that more than 94% of traders encounter enormous difficulties in preserving yams before sale (Figure 2). They mainly mentioned rotting. Only 6% felt that they did not encounter any difficulties.

3.4 Links Between Difficulties Encountered By Traders And Yam Varieties

Nearly 70% of traders believe that yam rots are related to the variety against 25% who do not think so, 6% did not give any answer. Regarding the most resistant or susceptible varieties, opinions differed from one trader to another (Figure 3).

Table 1. Distribution of yam traders by gender

	Workforce	Confidence interval
Male	15	[0,6875; 1,1875]
Female	1	[-0,1875; 1,1875]
Total	16	

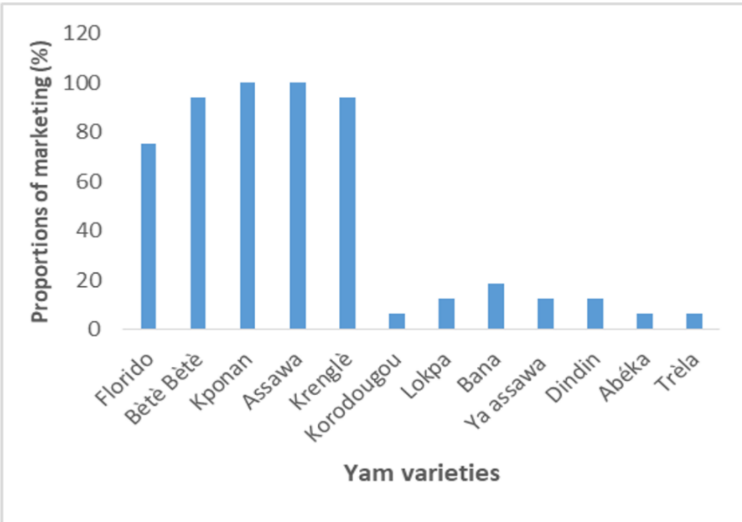

Fig. 1. Marketing rate of different varieties of yams in the markets of the communes of Treichville, Marcory, Koumassi and Port-Bouët

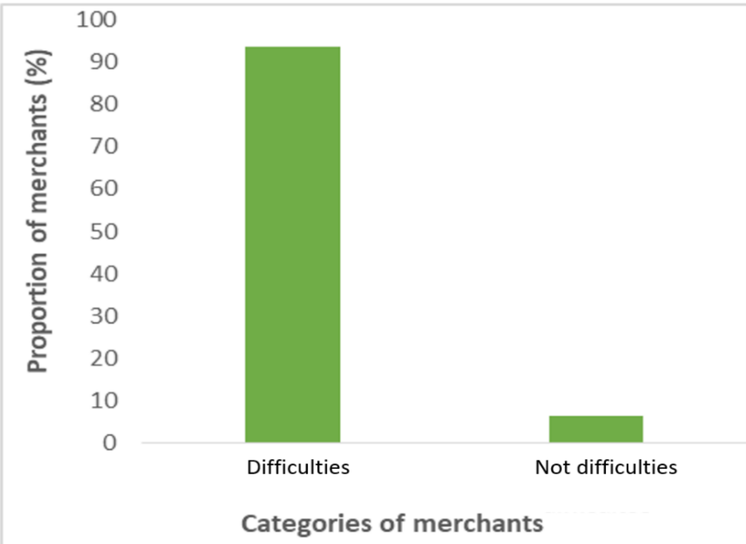

Fig. 2. Proportion of traders experiencing difficulties or not during yam storage

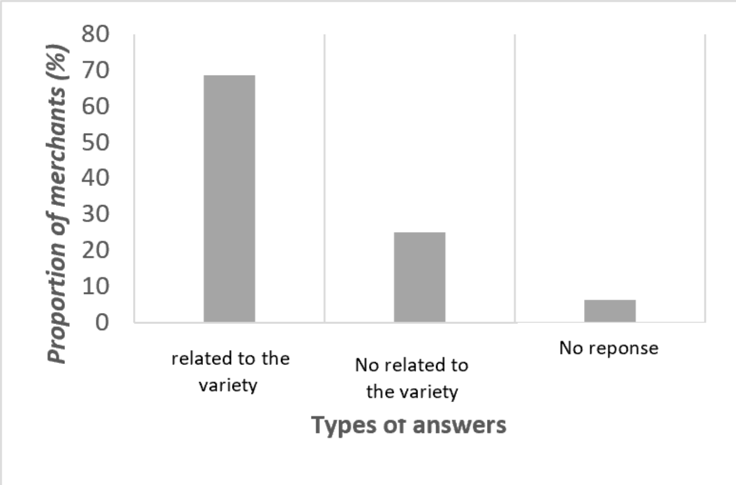

Fig. 3. Proportion of traders who believe that difficulties are related or not to the variety of yam

3.5 Time Of Appearance Of The First Signs Of Rot In Yam Varieties

Forty-four percent of traders believe that some yams arrive with rot on unloading, compared to 25% who believe that yams rot after two weeks to a month of storage (Figure 4). Only 6.75% said that yams can be stored for three months.

3.6 Types Of Rottenness Mentioned By The Merchants

The rots most encountered by yam traders were soft rots at 93.75% (Figure 5). Only 6.25% of them consider the rots to be dry.

3.7 Location Of Rots In Yam Tubers

Of the traders interviewed, 68.75% felt that yam rots do not have a preferred area (Figure 6). They can start at the "tail", head or middle of the yam. Only 31.25% of traders indicated that rots start at the head of yams.

3.8 Traders' Knowledge Of The Causes Of Rot

Regarding traders' knowledge of the causes of rot, 87.5% felt that they knew about them, compared to 12.5% who did not (Figure 7).

3.9 Factors Of Yam Rots

Several causes of rot were mentioned by traders during this survey. All traders (100%) felt that rot was caused by heat. Pesticides and synthetic fertilizers used by producers in the field were mentioned by 58% of them, and injuries during harvest came in third place with nearly 29% of traders (Figure 8). In contrast, fungi were not mentioned by traders as a cause of yam rot.

3.10 Estimated Losses Due To Rot

A proportion of 56.25% of traders revealed that they lost 10 to 20% of their inventory during storage, while 37.5% of them estimated it to be less than 10%. Those who lost less than 20% were in the order of 6.25% (Figure 9).

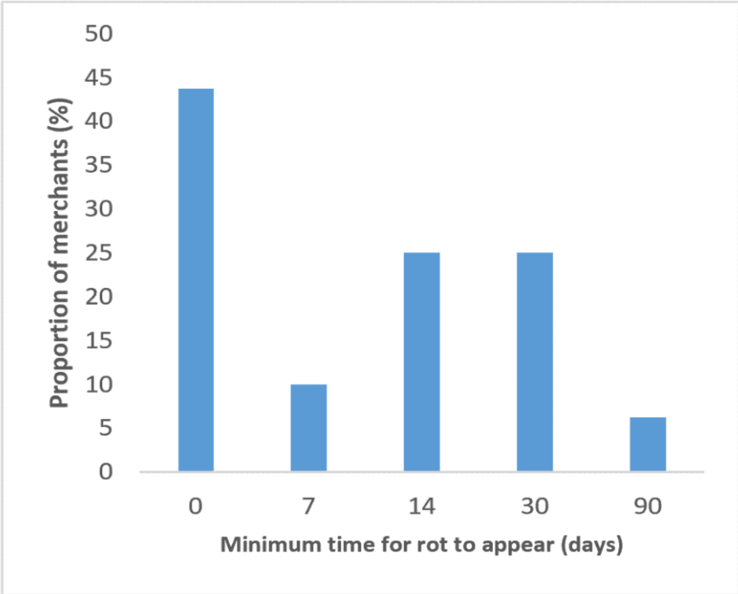

Fig. 4. Minimum storage time of yams rotting appears according to the traders

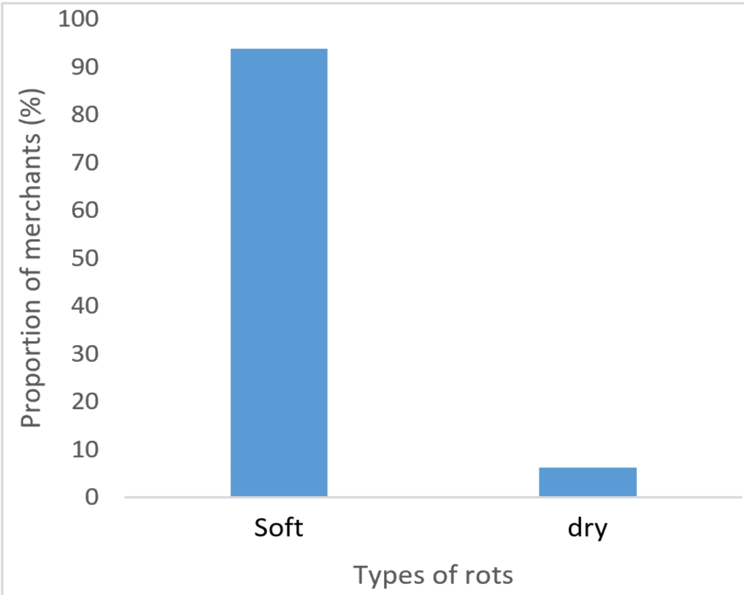

Fig. 5. Types of yam rots encountered by traders

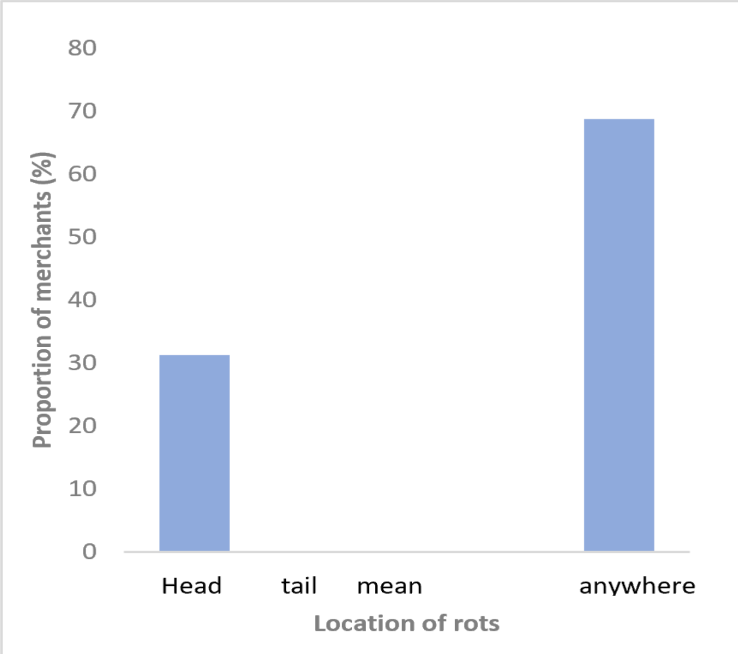

Fig. 6. Parts of the tuber where rot starts according to the traders

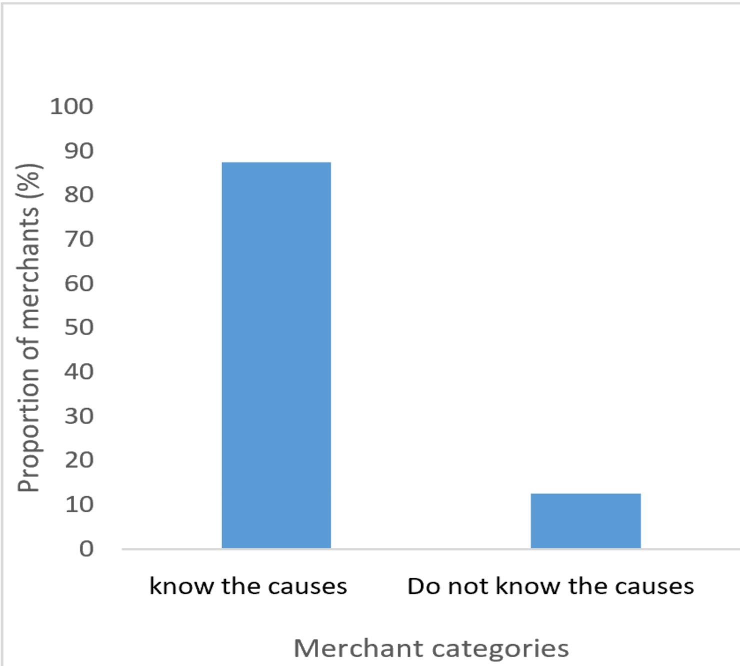

Fig. 7. Proportion of traders who know or do not know the causes of yam rots

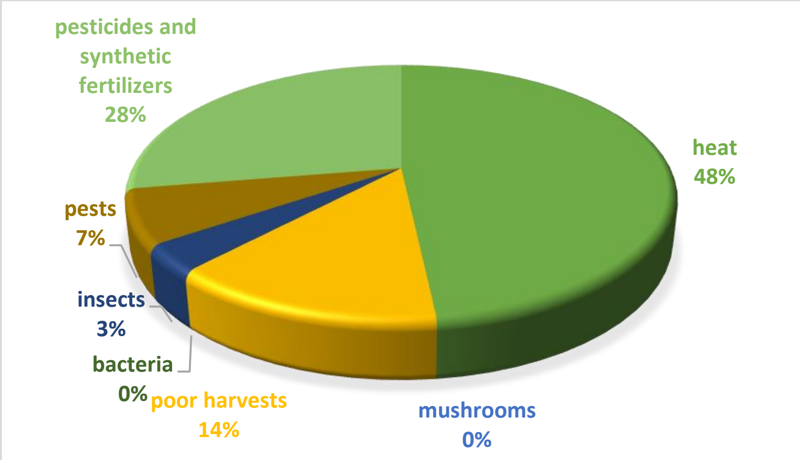

Fig. 8. Causes of yam rot according to traders interviewed

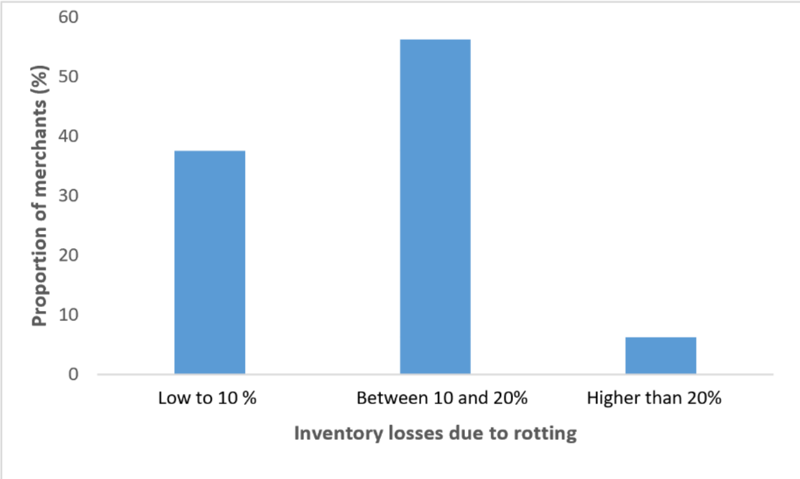

Fig. 9. Estimated losses due to yam rots according to traders interviewed

3.11 Rate Of Use Of Yam Preservation Techniques By Traders

The survey showed that 56.25% of traders used yam preservation techniques, compared to 43.75% who did not (Figure 10).

3.12 Different Techniques Of Yam Conservation By Traders

Fifty-seven percent of the yam traders surveyed use ventilation as a technique to combat heat, which they believe is the main cause of yam rot (Figure 11). Thirty-eight percent of them use wall partitions to ventilate their rooms. Only 5% of the traders surveyed sprayed their stores with insecticides.

3.13 Region Of Origin Of Yams Sold By Traders

Yam traders indicated that the regions of origin of the yams sold in their communes are Bondoukou, Bouna, Bouaké, Kouassikouassikro, Korhogo, Tanda and Agnibilékro. Among these areas, Bondoukou and Bouna are in the lead with 68.75% and 81.25% respectively. Next, the zones of Bouaké, Korhogo, Tanda and Agnibilékro came next with 50, 18.75, 12.5, 6.25, and 6.25 percent of yams sold, respectively (Figure 12).

3.14 Link Variety Of Yam Rots

Traders' responses on the relationship between yam rot types and variety are recorded in Figure 13. Nearly 70% believe that rots are related to yam variety, compared to 30% who believe the opposite.

3.15 LINK BETWEEN ZONES OF ORIGIN AND YAM ROT FREQUENCY

Figure 14 presents traders' estimates of yam rots in relation to areas of origin. They estimate that 40% of yams from Bouna have more rot, compared to 20% for Bondoukou, Bouaké and Kouassikouassikro.

3.16 TRADERS' EXPECTATIONS OF RESEARCHERS

The expectations of traders from researchers regarding yam rot control are shown in Figure 15. 50% of traders felt that they did not expect anything from researchers on this issue. A total of 26.66% wanted yam producers to use pesticides and synthetic fertilizers in their plantations in a rational manner. Only 23.33% of them felt that they were waiting for a product to be developed to treat yam rots in their stores.

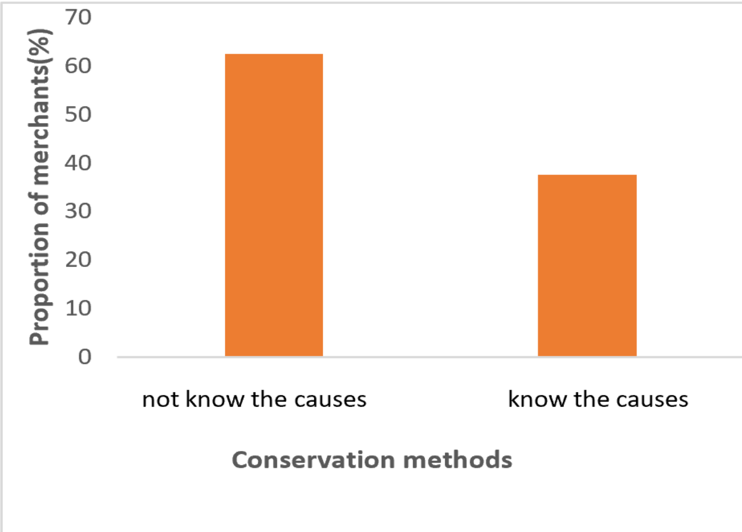

Fig. 10. Proportion of traders using or not using techniques during yam storage

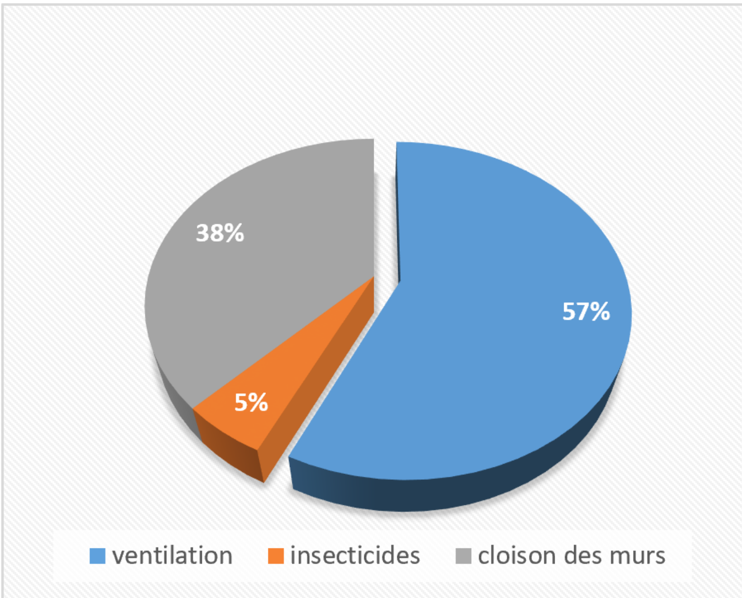

Fig. 11. Different techniques used by traders to preserve yams

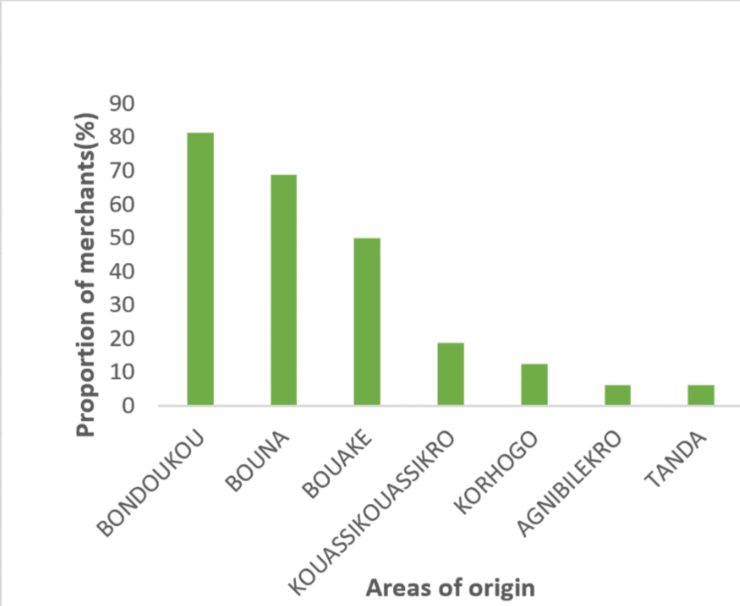

Fig. 12. Area of origin of yams sold by traders in the markets of Treichville, Marcory, Koumassi and Port-Bouët

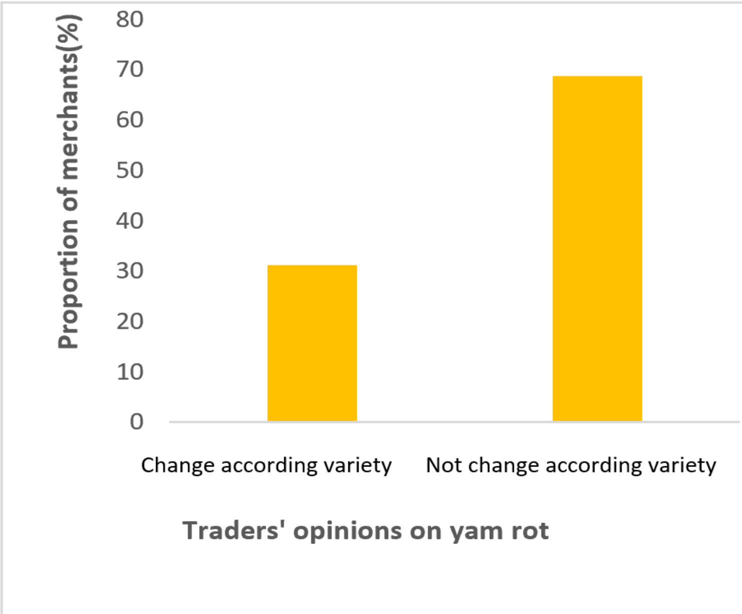

Fig. 13. Link between yam varieties and types of rots according to traders

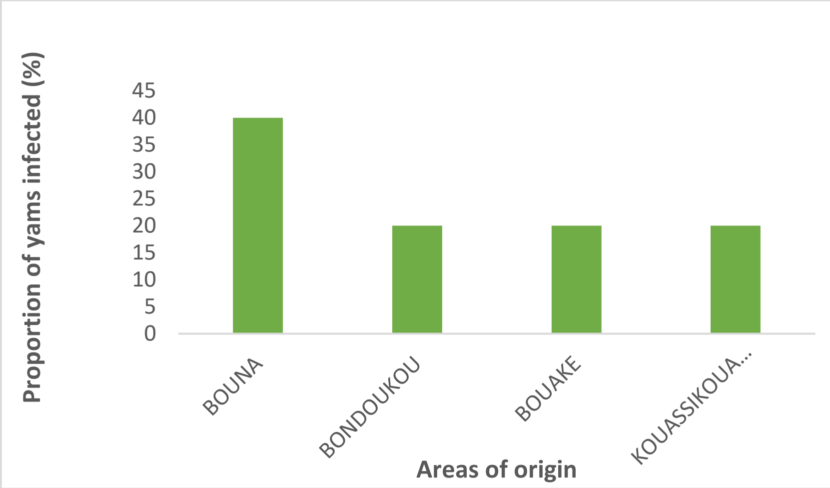

Fig. 14. Areas with the most infected yams according to traders

Fig. 15. Expectations of yam traders towards researchers

3.17 Education Levels Of Traders

The surveys provided information on the educational level of yam traders (Figure 16). There is a diversity of educational levels among traders (ddl = 3) (Table II). The most common level of education is illiterate with a frequency of 45%, followed by secondary education (37%). Those with a higher level of education represent 13%. The lowest frequency is observed among traders who have a primary level (6%).

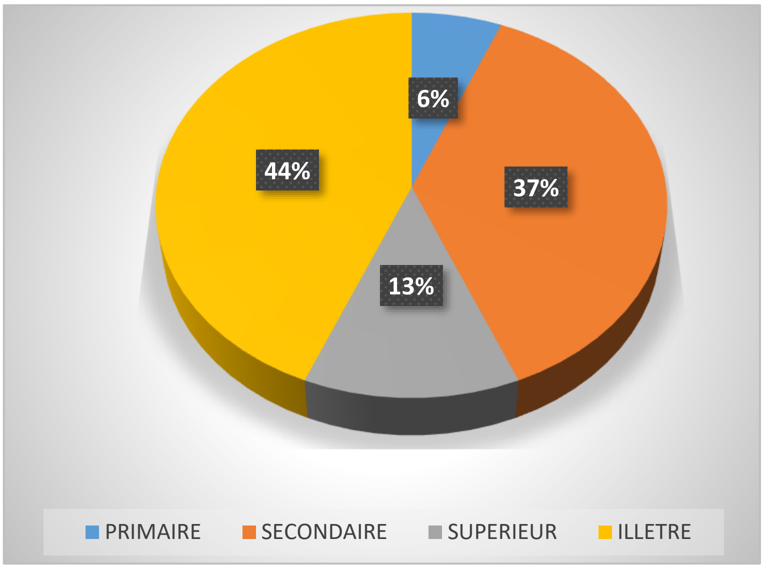

Fig. 16. Education levels of yam traders in Treichville, Marcory, Koumassi and Port-Bouët

Table 2. Distribution of yam traders by education level (N=16)

Level	Workforce	Confidence interval
PRIMAIRY	1	[-0,1875; 0,3125]
SECONDARY	6	[0,125; 0,625]
SUPERIOR	2	[-0,125; 0,375]
ILLETRATE	7	[0,1875; 0,6875]
Total	16	

4 Discussion

This study showed that the yam varieties most sold in the communes of Treichville, Marcory, Koumassi and Port-Bouët are Kponan, Assawa white and yellow, Krenglè, Bètè Bètè and Florido, compared to the varieties Fassadjô, Bana, Ya assawa, Trèla, Dindin, Korodougou and Abéka. According to traders, the latter are generally sold in small quantities and are not known by most consumers. Kponan is the most marketed variety because it is highly appreciated in all its culinary forms by consumers [11].

Almost all traders report difficulties in preserving yams. This is due to the fact that most traders, even those who think they know, do not know the real causes of yam rot. Heat was mentioned by all traders as the main cause of rot, with pesticides and fertilizers coming in second place, followed by poor harvesting. No trader mentioned microorganisms (fungi and bacteria) as a cause.

The vast majority of traders believe that rots are related to the variety. Opinions on which varieties are more resistant or susceptible vary from one trader to another. While some believe that Bètè Bètè rots very quickly, others maintain that this variety keeps well and for a long time. This second opinion is shared by the work of [12]. Florido was described by the majority of traders as resistant, and therefore keeps better. [13] noted that the Florido variety occupied a more important place on the market than Bètè bètè. As for Krenglè, more than a third of traders said that it is the most resistant but does not withstand dehydration. The Kponan and Assawa varieties were cited as the most sensitive because of their high water content. According to these traders, the yellow Assawa keeps better than the white. As for the Lokpa variety, all traders suggested that the Baule use this name to designate either Kponan or Assawa. This may be explained by the fact that the term Lokpa often encompasses all early two-harvest varieties [12].

The minimum storage time of yams is variously appreciated among traders. For some of them, symptoms of rot are observed even during the reception of the stocks. This is undoubtedly due to injuries during harvesting, poor handling during transport, and the synthetic pesticides and fertilizers used by producers, as mentioned by traders as the cause of rotting. In addition, the high water content of the tubers, associated with the injuries they suffer at harvest or afterwards, expose them to microorganisms [12]. Women traders who receive yams from the village estimate that some resistant varieties can be stored for three months.

Some traders believe that if storage conditions are well controlled, yams can last two weeks to a month before showing the first signs of rot. These conditions include aeration of the store, low humidity, and isolation of already affected tubers. This opinion is also shared by [12] according to whom, the modification and adaptation of traditional techniques have shown their potential to reduce qualitative and quantitative losses during yam storage. According to [14], forced ventilation could significantly reduce fresh material losses, even when applied to traditional storage. After 44 weeks of storage, losses on racks or in shaded enclosures were 90%, whereas with continuous or intermittent forced ventilation they were only 18.5% and 15.7%. The latter method may be of interest to wholesalers who have access to electricity. Soft rot is the most common method mentioned by traders. According to them, since the advent of fertilizers, dry rots are very rare. Similar observations were also made by [15] on *Dioscorea alata* var. Bètè-bètè and *Dioscorea cayenenis-rotundata* variety Krenglè in two markets in the District of Abidjan (in the communes of Adjamé and Abobo). The rots observed by these authors on the tubers were mostly soft. The rots do not have a fixed area of predilection in yam tubers. All parts are exposed and rots only appear on tubers that have been injured during harvesting and/or transport. However, about 30% of traders said that rots start at the "head" of the yam. The latter view is supported by a report by [16] that the "head" region of the tuber is more susceptible to rot than the middle and terminal (tail) regions. Most traders lose 10-20% of their stock during storage while 6.25% lose more than 20% due to rots. This was confirmed by [17] who stated that fungal rots cause the greatest storage losses. Also, it is known that yam, as well as other roots and tubers such as cassava and taro, suffer high post-harvest losses fluctuating between 25 and 60% [18], [19], [20]. According to [9], post-harvest rots of yam tubers are estimated at about 20-30% in Ivory Coast.

As for the techniques used during storage, 56% of traders use them. Among these techniques, ventilation (57%) and wall partitions (38%) are used to control heat, as pathogenic fungi of yam tubers thrive at high relative humidity and temperatures between 25 and 30°C [6]. Only 5% of traders use insecticides in the stores. The low proportion is explained by the fact that most traders think that nothing can be done about yam rots. Also, they are unaware of the real causes of rots, as 44% are illiterate.

Bondoukou, Bouna and Bouaké are the main cities of origin of yams with 81.68 and 50% of traders respectively. [21] stated that the Centre-East region represents one of the most important yam production basins in Côte d'Ivoire. It includes the pre-forest savannah zone and the Sudan savannah zone immediately adjacent to the mesophilic forest. Bouna is designated by 40% of traders as the area with the most infected yams. This could be explained by the long distance to the marketing areas. The two main varieties currently found on the market have the following prices per kilogram: 350-400 F CFA for Kponan and 250-300 F CFA for Assawa. This difference is explained by the fact that Kponan is more appreciated in all its culinary forms by consumers than Assawa [11].

Half of the traders admitted that they were not expecting any solutions to the difficulties they encounter in preserving yams. This is because, according to them, yam is a perishable commodity and nothing can stop it from rotting. Twenty-six percent (26%) of traders wanted producers to use fewer pesticides and fertilizers in the field to reduce the fragility of yams and reduce losses. About 24% expect that a product will eventually be made available to them to control rots. These traders are probably the ones who know the real causes of the difficulties they face.

5 CONCLUSION

This study provided a profile of yam traders in the communes of Treichville, Marcory, Koumassi and Port-Bouët and the difficulties they encounter when storing yams. The major difficulty mentioned concerns rotting during storage. The work carried out in this study is far from exhaustive and could lead us to carry out other in-depth research, including: isolating and identifying to species level the different fungi associated with these rots; developing control methods against these fungi; and evaluating the incidence of pathogens.

REFERENCES

[1] M. Demont, A. Houedjoklounon, J. Houhouigan, A. Mabyao, G. Orkwor, J. Tessens, E. Tollens, M. Touré, Etude comparative des systèmes de commercialisation d'igname en Côte d'Ivoire, au Bénin et au Nigéria, Katholieke Universiteit heuven working paper, n°79, p20, 2003.

[2] MINAGRA (Ministère de l'Agriculture et des Ressources Animales) Annuaire des statistiques Agricoles, Côte d'Ivoire: 23 p, 1991.

[3] T. Babaleye, An important success story of the International Institute of Tropical Agriculture (IITA) which has existed in Nigeria since its inception 36 years ago, is that of raising the status of the yam, a major food crop in West Africa. ANB-BIA SUPPLEMENT ISSUE/EDITION. n° 463, 3p, 2003.

[4] FAO. 2013. http//www.fao.org, Consulté le 16 février 2020.

[5] K. Sylla, Yam production and socio-economic environment. Agronomie Africaine, 4: 177-185, 2003.

[6] T. Ikotun, Pourriture microbienne post-récolte des tubercules d'igname au Nigeria. Fitopatologia Brasileira, 8: 1-7, 1983.

[7] A. Tschannen, Controlling postharvest losses of yam (Dioscorea spp.) by application of gibberillic acid. Dissertation n°14942, Swiss Federal Institute of Technology (ETH), Zurich, 138 p, 2003.

[8] FAO. 1988. Les cultures de racines et tubercules, les plantains et les bananes dans les pays en développement. Challenges and opportunities. Document de la FAO sur la production et la protection des plantes, n° 87 Anonyme Rome, Organisation des Nations unies pour l'alimentation et l'agriculture.

[9] P. Vernier & N. Bricas, Perspectives for the yam sector: the Cossette system removes several constraints. Bulletin du Réseau Technologie et Partenariat en Agroalimentaire 18: 8-12, 2000.

[10] M.O. Otusanya & M.J. Jeger, Effect of Aspergillus niger on shoot emergence and vine development in fieldsown yams (Dioscorea spp.) and rot development under long-terme storage conditions. International Biodeterioration and Biodegradation 38: 89-100, 1996.

[11] C. Nindjin, Study of the sensory qualities of Dioscorea alata yam tubers in conservation. Diplôme d'Etudes approfondies (D.E.A.), Department of Biochemistry, National University of Côte d'Ivoire 50 p, 1994.

[12] O. Girardin, Technologie après récolte de l'igname: étude de l'amélioration du stockage traditionnel en Côte d'Ivoire. Thèse n° 11710. Ecole Polytechnique Fédérale de Zürich, Suisse 136p, 1996.

[13] S. Doumbia, The adaptation of producers to the demands of commercial demand: The case of yam in Côte d'Ivoire. In: Griffon M, ed. Économie des filières en régions chaudes-Formation des prix et changes agricoles Montpellier, Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) P29, 1990.

[14] O. Mozie, Effect of air flow on weight losses and sprouting of white yam tubers (Dioscorea rotundata Poir) stored in the conventional barn. Tropical Root and Tuber Crops Newsletter, 12 and 13: 32-37, 1982.

[15] K.P. Assiri, A.H. Diallo & S. Aké, Evaluation of the antifungal potential of palm wine against fungi causing yam tuber rots (Dioscorea spp.) during field storage. Journal of Applied Biosciences, 29: 1753-1765, 2010.

[16] D.G. Coursey, Yams. Longmans London, 230 pp, 1967.

[17] M.O. Otusanya & M.J. Jeger, Effect of Aspergillus niger on shoot emergence and vine development in fieldsown yams (Dioscorea spp.) and rot development under long-terme storage conditions. International Biodeterioration and Biodegradation 38: 89-100, 1996.

[18] D.G. Coursey & R.H. Booth Post-harvest problems of non-grain staples. *Acta Horticulturae*, 53, 23-33, 1977.

[19] P.A. Lancaster & D.G. Coursey Traditional post-harvest technology of perishable tropical staples. FAO, Rome. 74 p, 1984.

[20] J.J. Asiedu, Yams. *Processing and physical / chemical properties of tropical products*. Anonymous pp.379-398, 1986.

[21] J. Miège, The economic importance of yams in Côte d'Ivoire. Distribution of crops and main varieties. Rev Int Bot Appl, 353-354, 144-155, 1952.